Department of Energy 3

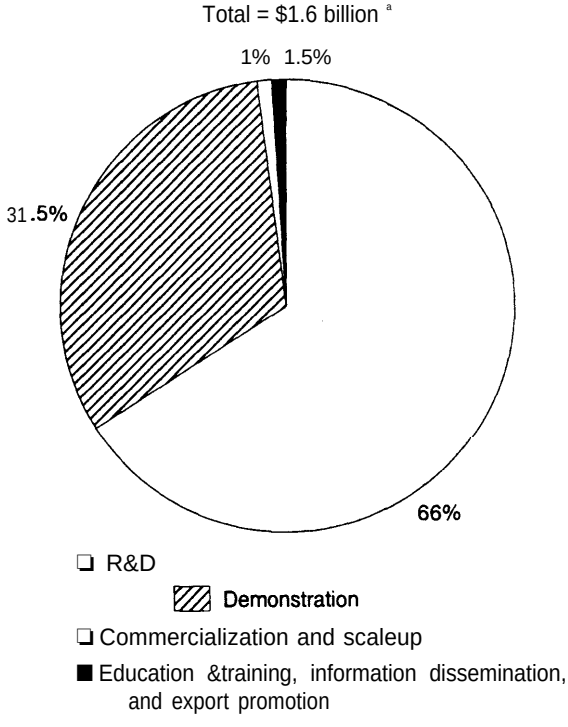
The Department of Energy (DOE) is both a major user and developer of environmental technologies. DOE supports research and development on technologies that allow energy to be produced, generated, transmitted, and used in cleaner ways. According to Clinton Administration data, it accounts for nearly three-fourths of federal agency spending on so called "avoidance technologies." DOE also administers the world's largest environmental restoration and management program to address contamination and waste management problems at its nuclear weapons research and production facilities.[1] Part of the cleanup and waste management budget supports development of specialized or potentially more cost-effective technologies to meet DOE's own cleanup and waste management needs.

Estimates of DOE's environmental technology spending in FY 1994 range from about $1 billion to $1.6 billion (depending on the definition of environmental technology). (See tables 2-1 and 2-2 in chapter 2). This is by far the largest of any federal agency and reflects the multiple dimensions of DOE's involvement in this R&D, from in-house cleanup to encouraging energy conservation.[2] DOE's energy and environmental technol-

[1] On the size of DOE's program, see Secretary of Energy Advisory Board, Task Force on Alternative Futures for the Department of Energy National Laboratories, *Alternative Futures for the Department of Energy National Laboratories*, (Washington, DC: February 1995). For discussion of DOE environmental problems, see U.S. Congress, Office of Technology Assessment, *Complex Clean Up: The Environmental Legacy of Nuclear Weapons Production*, OTA-O-484 (Washington, DC: U.S. Government Printing Office, February 1991).

[2] U.S. Congress, Office of Technology Assessment, *Industry, Technology, and the Environment: Competitive Challenges and Business Opportunities*, OTA-ISC-586 (Washington, DC: U.S. Government Printing Office, January 1994).

FIGURE 3-1: DOE Environmental Technology Budget by Function, FY 1994



[a]Total is based on NSTC data displayed in table 2-1 in chapter 2.

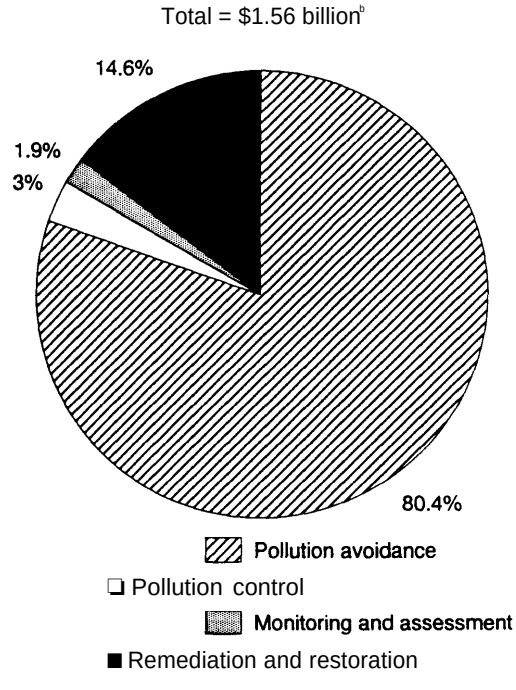
SOURCE: National Science and Technology Council (NSTC), Committee on Environment and Natural Resources (CENR), unpublished tables, 1994.

ogy activities in some instances cover the entire spectrum from basic research, through applied research and development, demonstration, testing and evaluation, to procurement, technical assistance, and export promotion. (See figures 3-1 and 3-2). However, most of the funds are spent on research, development, and demonstration (RD&D).

A sizable portion of DOE's research and development (R&D) is undertaken by the DOE laboratories, some of which are government operated and some of which are operated by contractors to DOE. DOE also supports environmental technology R&D by others, through grants, cooperative agreements, and other arrangements with industry, other private organizations, universities and other governmental bodies.

DOE's environmental technology R&D takes place in a broader context of intense debate about DOE's mission, both in Congress and the executive branch.[3] In February 1995, Secretary of Energy Hazel R. O'Leary pledged a $14.4 billion reduction in DOE's budget over the next five

FIGURE 3-2: Allocation of DOE Environmental Technology RD&D and Scaleup by Category,[a] FY 1994 (in percent)



[a]Proportions are based on National Science and Technology Council data on research and development, demonstrations, and scaleup, displayed in table 2-1 in chapter 2.
[b]Total is based on data displayed in table 2-1 in chapter 2.

SOURCE: National Science and Technology Council, unpublished data Apr. 6, 1995.

[3]Congress was in the process of considering Department of Energy appropriations for FY 1996 as this report went to press. The House Committee on Appropriations had just reported two bilk H.R. 1905 and H.R. 1977, pertaining to DOE R&D programs. House action was imminent.

years—a 17-percent reduction in DOE's budget over the period. Some in Congress have proposed elimination of DOE, with some of its functions distributed elsewhere within the government, and others either eliminated or privatized. Discussion also is underway about the mission of the DOE laboratories, especially the nine multiprogram national laboratories set up originally to develop nuclear weapons and energy. Several recent reports, such as by the so called Galvin Commission[4] and by the U.S. General Accounting Office (GAO)[5], have discussed options for revamping these laboratories, including their environmental R&D functions.

Environmental technology activities within DOE are carried out by several offices under several assistant secretaries. The Assistant Secretary for Energy Efficiency and Renewable Energy oversees energy related environmental technology development pertaining to industry, utilities, buildings, and transportation. The Assistant Secretary for Fossil Energy oversees DOE support for fossil energy R&D, some of which could lead to cleaner or more efficient production and use of fossil fuels. Cleanup and restoration are the responsibility of the Assistant Secretary for Environmental Management. The Assistant Secretary for Environment, Safety and Health has responsibility for assuring environmental integrity on DOE lands and facilities, and protecting the health and safety of DOE employees and citizens living near DOE facilities.

The discussion below focuses on selected DOE RD&D programs related to environmental technologies: environmental management and restoration, fossil fuel, energy efficiency, solar and renewable energy, and some other programs. The chapter appendix briefly discusses the role of DOE laboratories in environmental technology R&D, and mechanisms, such as cooperative research and development agreements (CRADAs), by which they carryout R&D with industry. However, activities of individual DOE laboratories are not discussed in detail. Other aspects of DOE's environmental technology activities, such as its role in technology transfer (aside from CRADAs), technical assistance, and energy and environmental technology export promotion also are not discussed in detail.[6]

ENVIRONMENTAL MANAGEMENT AT DOE FACILITIES

The Environmental Management (EM) program is responsible for identifying and reducing risks, and managing and treating nuclear and hazardous waste (and mixtures of radioactive and hazardous wastes) generated over the last half century at 137 DOE sites and facilities in 34 states and territories where nuclear energy or weapons research and production has been conducted.[7] EM's budget for waste management, cleanup, and other activities has grown from $ 1.7 billion when the program was set up in 1989 to roughly $6 billion in FY 1994.[8] Most of the budget covers direct costs for

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[4] Report by the Secretary of Energy Advisory Board, Task Force on Alternative Futures for the Department of Energy National Laboratories, op cit., footnote 1.

[5] See U.S. General Accounting Office, *Department of Energy: National Laboratories Need Clearer Missions and Better Management*, GAO/RCED-95-10 (Washington, DC: U.S. Government Printing Office, Jan. 27, 1995).

[6] For discussion of export promotion programs and environmental technology, see *Industry, Technology, and the Environment*, op. cit., footnote 2, pp. 151-181, and U.S. Congress, Office of Technology Assessment, *Development Assistance, Export Promotion, and Environmental Technology*, OTA-BP-ITE-107 (Washington, DC: U.S. Government Printing Office, August 1993).

[7] For perspective on the environmental management program, see U.S. Congress, Office of Technology Assessment, *Complex Clean Up: The Environmental Legacy of Nuclear Weapons Production*, OTA-O-484 (Washington, DC: U.S. Government Printing Office, February 1991), especially pp. 23-74.

[8] Department of Energy, *Environmental Management, 1995: Progress and Plans of the Environmental Management Program*, DOE/EM-0228 (Washington, DC: U.S. Department of Energy, 1995, p. 64).

TABLE 3-1: Environmental Management (EM) Technology Development Budget[a] ($ millions)

Subactivity	FY 1994 (actual)	FY 1995 (adjusted)[b]	FY 1996 proposal Clinton Administration
Treatment and remediation technologies	166.5	148.5	203.8
Innovative and crosscutting technology	81.5	80.2	80.2
Industry programs	26.3	42.8	41.2
Technology integration	18.6	9.7	17.0
Program support	37.2	32.2	33.3
Program direction	14.9	13.4	**15.0**
Education and integrated risk management initiative	21.5	39.2	0
Infrastructure program	27.2	32.8	0
Total	**393.8**	**398.8**[c]	**390.5**[c,d]

[a]Figures cited are program expenditures; these estimates are not comparable with estimates of RD&D activities in tables 2-1 and 2-2 in chapter 2. Figures may not add due to rounding.
[b]Figures adjusted to take into account FY 1995 rescissions in the EM program under Public Law 104-6.
[c]Education and integrated risk management and infrastructure have been transfered to other programs for FY 1996. Hence, the baseline budget for FY 1995 would not include these programs.
[d]The House Committee on Appropriations, in House Report 104-149, recommends $380.5 million for the program in FY 1996.

SOURCE: Department of Energy, 1995.

waste management and environmental restoration required of DOE under its more than 100 compliance agreements with states or other parties, or to comply with environmental regulations.[9] However, a small portion of the total (roughly 6 to 8 percent per year) has been allocated to new and innovative technology development. As the overall program has grown, the technology development component has grown from $183 million to $394 million in 1994 (see table 3-l). The estimated technology development budget for FY 1995 is $399 million (adjusted for rescissions made under Public Law 104-6).

The goals of the technology development program are to reduce risks to people and the environment, reduce cleanup costs, and find new technologies for environmental problems for which current solutions do not exist.[10] DOE has established five focus areas for EM technology development: [11]

- mixed waste characterization, treatment and disposal,
- radioactive tank waste remediation,
- contaminant plume containment and remediation,
- landfill stabilization, and
- facility deactivation and disposition.

Much of the EM technology program is carried out by DOE laboratories. However, a portion of the funds ($43 million in FY 1995) supports private sector or university RD&D on high-risk, potentially high payoff technologies that did not originate within DOE. The intent is to support the competitiveness of the U.S. environmental industry in its effort to develop commercially viable technologies broadly applicable to EM's mission.

The EM budget listed as technology integration in table 3-1 supports activities to demonstrate and test technologies under different field condi-

[9]Department of Energy, *Fiscal Year 1996 Congressional Budget Request, vol. 5, Environmental Management,* Washington, DC, February 1995, p. 29.

[10]Statement of R. J. Guimond, Rear Admiral, Principal Deputy Assistant Secretary for Environmental Management, Department of Energy, before the Subcommittee on Energy and Enviromnent, Committee on Science, House of Representatives, U.S. Congress, Washington, DC, Feb. 14, 1995, p. 33.

[11]Ibid., p. 15

tions and to evaluate the regulatory and marketing acceptability of these technologies. This is often done through contracts, subcontracts, or CRADAs with industry and universities. The technology integration budget also supports activities carried out by the Committee to Develop On Site Innovative Technologies (the so called DOIT Committee), comprised of key federal agencies and the Western Governors Association.

DOE has been criticized by the GAO and others for failing to see that innovative technologies demonstrated through the technology development program are used in the field in cleanup operations. Recently, DOE has made some management changes aimed at encouraging greater use of innovations. However, the technology development office still is not involved in some key decision points in selecting technology to be used for clean up. [12]

The size of the EM program as a whole could decline in the coming years. Secretary O'Leary says that the costs of the EM program will be reduced by $4.4 billion from what they would otherwise be over five years.[13] While productivity improvements are expected to cover part of the difference, some DOE projections show a gap between EM program resources and responsibilities.[14] The role of environmental technology development in a more resource constrained EM program is an important issue. In theory, technology development could lead to productivity gains that could reduce remediation costs, make cleanup practical on more sites, and improve the efficiency of waste management operations. It also could help reduce risks to workers, nearby communities, and the environment. However, other management options, such as adjusting cleanup demands to anticipated future landuse, could also be pursued.

FOSSIL ENERGY R&D PROGRAMS

The R&D component of the Fossil Energy program supports fundamental research and technology development related to production and use of natural gas, oil, coal and other fossil fuels. The purpose is to strengthen the technology base that can be tapped by industry as it develops new products and processes for the market. Part of this R&D is conducted through cost-sharing partnerships with industry, or grants to universities and other entities. Activities supported range from university and national laboratory based basic research to proofs of concepts by private firms. An objective of much of this R&D is to develop cleaner or lower environmental impact technologies for fossil fuel supply, conversion, delivery or use. Examples include R&D for advanced gas turbines and various cleaner coal technologies. Substantial fuel cell R&D is also administered under this program. The stated rationales for this fossil fuel R&D are to benefit the nation through lower energy costs, reduced environmental impact, increased technology exports, and reduced dependence on insecure energy sources.

The total R&D component of the Fossil Fuel program amounted to $426 million in FY 1994 and an estimated $442 million in FY 1995. Funding for the program is likely to fall appreciably in FY 1996.[15]

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[12] U.S. General Accounting Office, *Department of Energy: Management Changes Needed to Expand Use of Innovative Cleanup Technologies*, GAO/RCED-94-205 (Washington, DC: U.S. Government Printing Office, August 1994).

[13] The Clinton Administration's budget proposal for FY 1996 sought an increase in the EM appropriation for FY 1996; however, this reflects EM taking on added responsibilities at several high-risk DoD program sites, including the Savannah River site in South Carolina. *Fiscal Year 1996 Congressional Budget Request, vol. 5*, op. cit., footnote 8, p.4.

[14] Environmental Management, 1995, op cit., footnote 7, p. iii.

[15] The magnitude of the reductions was still uncertain in June 1995, as this paper went to press. A DOE authorization bill was under consideration by the House Committee on Science. Its Subcommittee on Energy and Environment had just acted on a proposal, subsequently introduced as H.R. 1816, which would authorize $204 million in FY 1996 appropriations for fossil fuel R&D. The House Committee on Appropriations recommended a higher level—$384.4 million for the programs for FY 1996, but stated an intention to reduce funding for this activity by 10 percent each year over the next four years, noting that this gradual reduction would reach a future level more in line with that proposed by the authorizing committee. (The Clinton Administration initially sought $437 million for these programs in its FY 1996 budget proposal).

TABLE 3-2: Selected Components of DOE's Fossil Fuel R&D Budget[a] ($ millions)

			FY 1996 proposals		
	FY 1994 (actual)	FY 1995[b] (estimate)	Clinton Administration	Mark by House Subcommittee on Energy and Environment	House Committee on Appropriations Recommendation
Coal	41.0	38.5	16.6	5.3	23.8
Advanced clean fuels	96.1	90.5	73,4	23.7	79.8
Advanced clean and efficient power systems	28.8	25.4	25.4	21.0	22.7
Advanced research and technology development					
Gas	43.7	66.7	90.4	26.4	60.3
Natural gas	51,1	49.6	55.5	31.5	53.5
Fuel cells					
Oil technology	74.3	81.7	86.8	41.2	63.8
Other	91.1	89.4	88.6	54.9	80.7
Total	**426.0**	**441.8**	**436.5**	**204.0**	**384.5**

[a]Figures cited are program expenditures; these estimates are not comparable with estimates of RD&D activities in tables 2-1 and 2-2 in chapter 2. Only part of the program expenditures listed above are for environmental technology
[b]Estimates do not reflect possible rescissions proposed for FY 1995.
[c]Subcommittee of Committee on Science.

SOURCE: Department of Energy, 1995; Subcommittee on Energy and Environment, Committee on Science, House of Representatives, U.S. Congress, "Chairman's Mark, U.S. Department of Energy, FY 1996 Authorization," June 8, 1995; Committee on Appropriations, House of Representatives. U.S. Congress, *Department of Interior and Related Agencies Appropriations Bill, 1996,* House Report 104-173, June 30, 1995.

Table 3-2 shows components of the program, and how these activities are allocated among different fuels. Only a portion of these funds should be considered environmental technology RD&D. DOE identified $314 million in fossil fuel projects as focused environmental technology activities in the data it submitted to the interagency Committee on Environment and Natural Resources (CENR). (See chapter 2 for discussion of CENR data).

A separate activity, the Clean Coal Technology Program, has been underway for 10 years. The program has cost-shared 45 demonstrations with industry, and entailed $2.3 billion in federal funds since its inception. (Total public and private spending on the demonstrations is estimated to be $6.9 billion; provisions exist for recouping government funds if technology is commercialized). Six of these demonstrations have been completed; another 24 are expected to be completed by the end of FY 1996, according to the Clinton Administration. As suggested by the figures in table 3-3, support for this forward funded program is being phased down.[16]

ENERGY EFFICIENCY PROGRAMS

DOE's energy efficiency activities fall out under four broad end-use areas-transportation, utilities, buildings, and industry. Offices exist for each of these areas, as well as a crosscutting national program office. As with several DOE programs, a full range of activities, including basic and applied research, demonstration projects, technical assistance, and evaluations, may be supported. Most of the projects are conducted with industry participants, who typically pick up one-third to one-half of the costs.

[16]Due to a combination of prior appropriations and rescissions in Public Law 104-6,$150 million in budget authority would be available for obligation in FY 1996 under the Clean Coal Program. The Clinton Administration initially sought $45 million for the program in FY 1996 but subsequently amended the request to about $10 million. H.R. 1816 (as introduced) would not authorize FY 1996 appropriations to be used for the program. The House Appropriations Committee recommended no new budget authorization for the program in FY 1996, noting that, with the rescission. $150 million would be available in FY 1996.

TABLE 3-3: Clean Coal Technology Program ($ millions)

			FY 1996 proposals		
	FY 1994 (actual)	FY 1995 (estimate)	Clinton Administration [b]	H.R. 1816 (as introduced)	House Committee on Appropriations Recommendations
Clean Coal Technology Program	221.5	37.1	10.0	0	**No** new budget authority

[a]The Clean Coal Program IS forward funded Advance appropriations of $200 million had been made available for obligation in FY 1996 in prior appropriations acts However, Public Law 104-6 rescinded $50 million from funds available for obligation in FY 1996 Hence the total available for obligation in FY 1996 IS$150 million.
[b]The administration originally sought $45 million for the program.

SOURCE: Department of Energy, 1995; H.R. 1816 (as Introduced); Committee on Appropriations, House of Representatives, U.S. Congress, *Department of Interior and Related Agencies Appropriations Bill,* 1996, House Report 104-173, June 30, 1995.

While primarily concerned with energy conservation, much of the R&D supported by these offices can lead to technologies that produce important environmental benefits due to reduced energy use and associated pollution. Whether to call these technologies energy or environmental technologies is often arbitrary. For example, the Industrial Waste Reduction Program carried out by DOE's Office of Industrial Technologies (OIT) is one of the largest sources of federal funds for industrial pollution prevention R&D.

In some cases. R&D conducted by the energy efficiency programs contributes to multiagency initiatives, such as the Partnership to a New Generation of Vehicles (PNGV) and the Climate Change Action Plan (CAP). Funding for all energy efficiency R&D (excluding technical assistance) under the four end-use offices programs was $388 million in FY 1994. (See table 3-4). Most of this ($334 million) was for activities that supported PNGV or CAP objectives, or was identified as focused environmental technology R&D by the CENR.

While the Clinton Administration sought major increases for these activities in its FY 1996 budget proposal, Congress is considering significant reductions. H.R. 1816, for example, would authorize $206 million for the programs in FY 1996.

Transportation Technology: Environmentally pertinent R&D supported by DOE's Office of Transportation Technologies includes technologies focused on clean-car and electric-vehicle-related programs. DOE is a major participant in the Clinton Administration's Partnership for a New Generation of Vehicles, which is coordinated through the National Science and Technology Council discussed in chapter 1. The transportation office supports, among other things, R&D for increasing fuel efficiency, development of electric and hybrid propulsion and battery systems, and advanced fuel cell technologies. DOE identified about $165 million in such activities for FY 1994.

Building Technology: Building technology related to environmental issues is mainly concerned with energy conservation. Many of the activities supported through this office contribute to objectives of the Global Change Action Plan. Some building technology programs support R&D toreduce use of, or find alternatives for, chlorofluorocarbons (CFCs) in making building materials, and in refrigeration systems and air conditioning. CFC use is being phased out under an international agreement, as these substances contribute to ozone depletion in the stratosphere.

Utility Technologies: Among other things, DOE's Office of Utility Technologies supports a range of renewable energy alternatives, such as solar, wind, geothermal, ocean-based, hydroelectric, biomass, and photovoltaic alternatives to fossil fuel produced power. These are discussed in the next section.

Industrial Technologies: The goal of OIT's Industrial Waste Reduction Program (IWRP) is to "improve the energy efficiency and competitiveness of private industry through cost-effective waste material reduction." IWRP focuses on the highly polluting processing industries, including

TABLE 3-4: Energy Conservation Research and Development—Selected Activities[a,b] ($ millions)

			FY 1996 proposals		
	FY 1994 (actual)	FY 1995[c] (estimate)	Clinton Administration	H.R. 1816 (as introduced)	House Committee on Appropriations Recommendations
Building technology	80.7	115.6	154.8	40,1	92.7
Industrial technology	123.9	135.2	172.9	51.1	110.7
Transportation technology	176.9	206.3	262.3	106.7	177,1
Utility technology	6.7	8.8	9.9	0	0
Policy and management	4.7	8.3	11.3	0	7,7
Total	392.9	474.2	611.2	198.0	388.4

[a]Figures cited do not include technical and financial assistance
[b]Figures cited are program expenditures, these estimates are not comparable with estimates of RD&D activities in tables 2-1 and 2-2 in chapter 2. Only part of the program expenditures are for environmental technology R&D.
[c]Some portion of the total may be subject to rescission.

SOURCE: Department of Energy; H.R. 1816 (as introduced); Committee on Appropriations, House of Representatives, U.S. Congress, *Department of Interior and Related Agencies Appropriations Bill, 1996,* House Report 104-173, June 30, 1995.

pulp and paper, oil refining, chemicals, steel, aluminum, foundries, and glass. These industries are major users of energy and their operations often produce significant environmental impacts. The costs of projects are usually shared with private companies or industry trade associations. IRWP activities fall under five categories: waste characterization, opportunity assessments, institutional analysis, technology research and development, and technology and information transfer. Data prepared for the CENR shows about $90 million was spent on focused environmental technology R&D under this program in FY 1994.

OIT is undertaking the Industry of the Future project,[17] which seeks to augment energy, economic. and environmental benefits from government technology investments. Several industry-led efforts to articulate long-term technology needs are underway; the industries involved are energy and pollution intensive.

Another OIT activity is the National Industrial Competitiveness through Energy, Environment and Economics (NICE[3]) Program, which is jointly managed with EPA. Begun in 1990, the program provides small research grants for technology development that would simultaneously conserve energy, reduce waste and pollution, and improve competitiveness. NICE[3] seeks to involve industry in developing such process modifications. Another purpose is to promote coordination and cooperation among EPA, DOE, and government offices at the state, regional, and federal level. OIT maintains that industry contributes four dollars to the program for every dollar contributed by DOE. [18]

A recent DOE report claims that successfully commercialized OIT technologies have produced cumulative energy savings of $2.2 billion, and have also reduced industrial emissions of particulate, sulfur dioxide, carbon dioxide, and volatile organic compounds. [19]

SOLAR AND RENEWABLE ENERGY

Funding for all DOE solar and renewable energy activities was $324 million in FY 1994 (see table 3-5). The lion's share went to solar energy, which

[17] Office of Industrial Technologies, Department of Energy, *Industries of the Future, Energy Efficiency for Our Sustainable Future,* Washington, DC, September 1994.

[18] Ibid., p. 16.

[19] As indicated in Department of Energy, Office of Energy Efficiency and Renewable Energy, *Technology Partnerships: Enhancing the Competitiveness, Efficiency, and Environmental Quality of American Industry* (Springfield, VA: National Technical Information Service, April 1995), pp. 5-16.

TABLE 3-5: DOE Solar and Renewable Energy Program—Selected Activities[a] ($ millions)

			FY 1996 proposals	
	FY1994 (actual)	FY1995[b] (estimate)	Clinton Administration	House Committee on Appropriations Recommendation[c]
Solar energy	$242.3	$292.2	$326.4	$149.2
Geothermal	23.0	37.8	37.0	25.7
Hydroelectric systems	1.0	4.8	1.0	0
Hydrogen research	9.6	9.6	7.3	15.
Electric energy systems and storage	44.2	44.4	46.9	28.9
Policy and management	3.7	4.8	4.8	2.8[d]
Total	323.8	393.6	423.4	221.6

[a]Figures cited do not include In-house energy management. Figures are program expenditures; these estimates are not comparable with estimates of RD&D activities in tables 2-1 and 2-2 in chapter 2. Only part of the program expenditures are for environmental technology R&D
[b]Figures may be affected by rescission.
[c]As Indicated in H.R. 1905 (as reported) and House Report 104-149
[d]This figure does not include an earmark of $44.8 million in energy supply R&D funds for the innovative Renewable Energy Technology Transfer Program authorized by section 1211 of The Energy Policy Act of 1992 (42 U.S.C. 13316). The earmark was added by the t-louse during the debate on H.R. 1905.

SOURCE: Department of Energy, 1995; *Inside Energy/With Federal Lands* (weekly newsletter) (New York, NY: McGraw Hill, June 19, 1995).

includes photovoltaics, solar thermal, biofuels, and wind energy. The remainder was distributed among programs for geothermal energy, hydroelectric research, hydrogen, and electric energy systems and storage. Depending on the program, these funds were used to support a broad spectrum of activities, ranging from basic research, development and demonstrations, to field testing and evaluation in cooperation with industry, to support for technical assistance and export promotion. The CENR data on focused projects identified $177 million in solar and $43 million in other renewable energy environmental technology projects in FY 1994; environmental technology was a contributing factor in other projects as well.

DOE's objectives for the solar and renewable programs include contributions to national energy security, enhancement of worldwide sales of U.S. energy products, improvement of industrial competitiveness, and technology transfer. In many cases, solar and renewable applications also could have environmental benefits.

Much of the R&D is carried out through the National Renewable Energy Research Laboratory and other DOE laboratories, including Sandia and Los Alamos. These laboratories also have longstanding programs. DOE's Office of Utility Technologies (described earlier) and other sector offices administer programs. Many of the activities are carried out in close cooperation with industry.

Funding for solar and renewable energy R&D is likely to be scaled back appreciably in FY 1996 (see table 3-5).

OTHER PROGRAMS

Office of Energy Research: Some of the research supported by this office on global change, modeling of environmental and energy systems, bioremediation, hazardous wastes and other subjects is pertinent to environmental technology. CENR identified $176 million of the office's budget as focused R&D on environmental technology. However, much of this supports modeling global change, which is not considered environmental technology R&D in this paper.

Bioremediation Environmental Technology Partnerships: Bioremediation uses microorganisms or other living organisms to transform waste products into less harmful substances. The Clinton Administration seeks $6 million to launch this cooperative program with industry. The purpose will be to field test microorganisms already identified as useful in bioremediation, and to identify

and manipulate other microorganisms thought capable of transforming other contaminants. Two research sites suitable for long-term evaluation of bioremediation strategies would be selected. The program would be carried out in DOE's Biological and Environmental Research Program.

Inventions and Innovations programs: Administered by the Office of National Programs under the Assistant Secretary for Energy Efficiency, DOE's inventions and innovations programs focuses on independent inventors and small businesses. In addition to grants to help develop promising inventions and innovations, the programs also conduct commercialization workshops and training sessions, and help showcase technologies through fairs and publications.

Other DOE programs may from time to time support environmental technology R&D or other related activities. In addition, DOE is a major participant in several interagency activities concerning environmental technology, including the Interagency Environmental Technologies Office.

APPENDIX 3-1: ROLE OF THE DOE NATIONAL LABORATORIES

The Department of Energy (DOE) laboratories conduct mission oriented research and development (R&D) in areas considered to serve U.S. national interests. The laboratories have traditionally emphasized defense and energy related research including nuclear weapons and atomic energy R&D, alternative energies, and other work related to national security. In FY 1994, DOE spent approximately $6.6 billion on R&D. Of that total, $3.8 billion (58 percent) was spent on R&D conducted at the National Laboratories.[20] Other federal agencies, such as the Department of Defense, also fund research at the Laboratories. The Laboratories' research covers a broad spectrum of basic sciences and applied technologies, including environmental technology related R&D.[21]

The DOE laboratories include the large multiprogram laboratories, and many smaller single-program laboratories supported by DOE. The multiprogram laboratories are all government-owned, contractor-operated (GOCO) facilities that conduct research on many different topics. These laboratories are Argonne National Laboratory, Brookhaven National Laboratory, Idaho National Engineering Laboratory, Lawrence Berkeley Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, Pacific Northwest Laboratory, and Sandia National Laboratories. As large multiprogram facilities, with budgets exceeding $1 billion in many cases, most of these laboratories perform some energy efficiency or environmental technology related R&D.

In addition to the multiprogram GOCO laboratories, DOE supports several single-program research facilities that perform energy and environmental technology R&D. Some of these National Laboratories are government-owned and government-operated (GOGO), while others are operated by contractors. The largest of the single-program laboratories performing energy and environmental research are:

- Morgantown Energy Technology Center, a GOGO laboratory,
- National Renewable Energy Laboratory, a GOCO laboratory,
- Pittsburgh Energy Technology Center, a GOGO laboratory,

[20] National Science Foundation, *Federal Funds for Research and Development: Fiscal Years 1992, 1993, and 1994*, volume 42 (Washington, DC: 1994).

[21] Department of Energy, *Technology Transfer 92/93* (Washington, DC: U.S. Government Printing Office, 1992).

- Savannah River Technology Center, a GOCO laboratory, and
- Westinghouse Hanford Company, a GOCO laboratory.[22]

Technology transfer and cooperative research have become increasingly important activities at the DOE laboratories.[23] Several mechanisms exist for DOE to interact with the private sector, including:

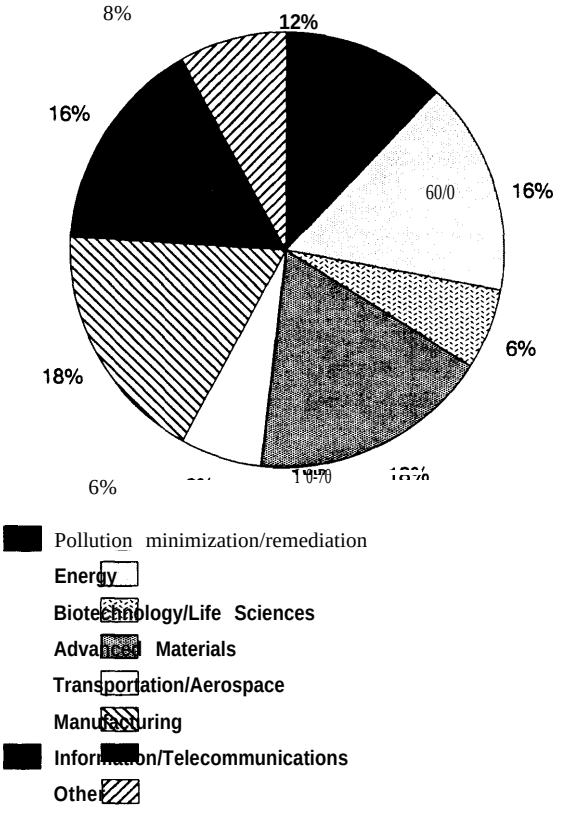
- cost-shared contracts and subcontracts,
- cooperative research and development agreements,
- reimbursable work for others agreements,
- technical assistance agreements,
- scientific personnel exchanges,
- materials transfer agreements,
- software licenses, and
- government patent licensing agreements.

One method of interaction is through cooperative research and development agreements. About 12 percent of CRADAs at the National Laboratories pertain to pollution prevention and remediation (see figure 3-3); in addition, many CRADAs categorized in other areas, such as transportation and energy, may have environmental components.

As defined and authorized by law, a CRADA is an agreement between one or more federal laboratories and one or more nonfederal parties, under which the government laboratory provides personnel, services, facilities, equipment. or other resources (but not funds), and the nonfederal parties provide funds, personnel, services. facilities, equipment, or other resources toward the conduct of specific research or development efforts (15 U.S.C. 3710a[d][l]). CRADA research projects, which usually are conducted in partnership with a company or consortium of companies, need to be consistent with the central mission of the laboratory.

In some cases, the companies come out of CRADAs with rights to keep laboratory notebooks, and information can be protected from

FIGURE 3-3: Distribution of 1995 CRADAs by Kind of Technologies



SOURCE: M. Chalhoub, "Pubic-Prwate Partnerships through Cooperative Research and Development Agreements Role of the National Labs in Commercializing Environmental Technologies," contract document prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, 1995.

[22] Ibid.

[23] Under the Stevenson-Wydler Technology Transfer Act of 1980 (Public Law 96-480), Federal Technology Transfer Act of 1986 (Public Law 99-502), and National Competitiveness Technology Transfer Act of 1989 (Public Law 101-1 89) the large multiprogram GOCO National Laboratories have been authorized and encouraged to transfer technology to the private sector. L. Rudolph. "Review of Federal Technology Transfer Law and Implementation by federal Agencies," *Federally Funded Genome Research: Science and Technology Transfer Issues, Proceedings* of a Public Meeting, May 21, 1992. Genome Patent Working Group, Committee on Life Sciences, Federal Coordinating Council for Science, Engineering, and Technology. Office of Science and Technology Policy (Washington, DC: U.S. Government Printing Office, 1992).

general dissemination for up to five years.[24] The federal government retains nonexclusive royalty-free worldwide rights to CRADA inventions and discoveries, including the right to have products manufactured by another company for the government's use.

DOE CRADAs have grown at a relatively faster pace over fewer years than CRADAs at other federal research institutions, according to an OTA contractor sample of CRADAs at several federal research agencies.[25] In April 1991, DOE had 12 CRADAs at its laboratories. As of January 1995, DOE CRADAs have grown to a total of 1,157 ongoing CRADAs, including 152 identified as environmental technology R&D.[26] Many other CRADAs on other research topics may have an environmental component as well.

DOE supports environmental research through both the Energy Research Program (ER) and the Defense Program (DP) at the National Laboratories. Some DP laboratories—Y12 at Oak Ridge, Sandia, Los Alamos, Lawrence Livermore—participate in a process to determine jointly the priorities among proposed CRADAs for allocation of their CRADA funding.[27] DP CRADAs are required to be "dual use" CRADAs—i.e., demonstrate both a defense-related and a nondefense-related use for the research. ER CRADAs are generally funded on the laboratory side by block funding, where DOE pays the laboratory a block amount for a specified set of deliverables. The laboratory then must find a company that might want a CRADA, referred to as a spinoff CRADA.[28] One benefit of having laboratories seek corporate CRADA partners, rather than the reverse, is that the companies may become involved at an earlier stage of the research.

According to a recent industry survey, most companies are primarily interested in accessing expertise and unique facilities at federal laboratories, as opposed to establishing a collaboration toward direct product development for sale in the marketplace.[29] The survey data implied that the purpose of entering into CRADAs or other collaborative relationships with the laboratories is less to license anything so developed than to undertake research.

Recently, CRADAs have prompted controversy. Some policymakers view CRADAs as mechanisms for unwarranted support of research that should be left to industry. Some see CRADAs as a form of subsidy to industry, at a time of increasing federal budget constraints. Some proposals advocate that DOE CRADAs be terminated and that some National Laboratories be privatized or terminated. Proponents of CRADAs view them as mechanisms for federal laboratories to leverage resources provided by their CRADA partners in areas relevant to DOE missions, and for laboratory personnel to gain knowledge through collaborations.

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[24] D. Blumenthal and N. Causino, "Life Science CRADAs at the National Institutes of Health and Department of Energy Laboratories," contractor document prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, February 1994.

[25] D. Blumenthal and N. Causino, "DOE and NIH CRADAs," contractor document prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, April 1993.

[26] M. Chalhoub, "Public-Private Partnerships through Cooperative Research and Development Agreements: Role of the National Labs in Commercializing Environmental Technologies," contract document prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, April 1995.

[27] D. Blumenthal, and N. Causino, "Life Science CRADAs at the National Institutes of Health and Department of Energy Laboratories," contractor document prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, February 1994.

[28] Ibid.

[29] J.D. Roessner, "What Companies Want From the Federal Labs," *Issues in Science and Technology* 10:37-42, 1993.

Access to National Laboratory expertise, research tools, and scientific capabilities is by no means limited to CRADAs. According to DOE officials, the National Laboratories generally negotiate thousands of non-CRADA agreements annually. For example, cost-shared contracts and subcontracts with other partners are an important method for joint technology development with DOE.[30] These agreements can be used to leverage federal resources through cost sharing with the private sector and other federal agencies. Some of these R&D partnerships seek to accelerate and facilitate demonstration of promising environmental remediation technologies while reducing costs. Contracts are supported by direct funding from DOE, and subcontracts are awarded to R&D laboratories.[31] In FY 1994, 39 percent of DOE/Environmental Management Technology Development funding was in the form of contracts or subcontracts. These most often involve industry partners, universities, or interagency agreements with other federal agencies. DOE sources claim that this mechanism spreads risk, and stretches federal R&D funding by leveraging the participation of partners.[32]

[30] Information provided by the Office of Environmental Management, Department of Energy, Washington, DC, May 1995.

[31] Ibid.

[32] Ibid.